MEASURING CHRONIC FOOD INSECURITY WITH FOOD BANK USER DATA: IMPLICATIONS FOR GENDER DISPARITIES IN CHRONIC HEALTH

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Abstract

Food insecurity is a key social determinant of health and an important risk factor in numerous health conditions. Evidence indicates that food insecurity impacts men and women differently with women experiencing higher rates of reported food insecurity and a higher correlation of that insecurity with chronic health conditions like diabetes and obesity. One possible explanation for this difference could be that women are more likely to find themselves in a chronic, predictable state of food insecurity while the male experience is more likely to be unpredictable and transient. Yet, the traditional reliance of food security research on the Census Bureau's Current Population Survey Food Security Supplement has limited the investigation of these temporal dynamics. Using food bank usage as a proxy for food insecurity, the cumulative number of food bank appearances and the average interval between appearances were compared between men and women. Multivariate ordinary least squares regression analyses were performed, and after controlling for family size and composition, access to food bank services, and socio-economic estimates, households headed by women were found to have significantly longer average intervals, and after controlling for average interval length, more cumulative visits to the food bank. Taken together, these facts suggest that female-headed households are more likely to experience chronic food insecurity.

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1. Introduction

Social determinants of health are “the conditions in which people are born, grow, live, work and age" and “the fundamental drivers of those conditions.”[1] Recently, there has been an increasing awareness of the impact that these socio-economic and environmental factors have on public health. As observational evidence has mounted, social determinants of health have become an increasingly prominent subject of public health investigations and an important target for public policy initiatives.

From this recent proliferation of research, food security, in particular, has emerged as an important social determinant of health. Defined as “the state of having reliable access to a sufficient quantity of affordable, nutritious food,” the absence of food security (i.e., food insecurity) can have acute health implications such as malnutrition and starvation. But in the modern societies, where calorie-dense, shelf-stable food is often cheaply and readily available, food insecurity has been found to be a contributing factor toward a host of chronic health conditions including, counterintuitively, obesity.[2]

Food insecurity in the developed world, therefore it would seem, is a complex, multidimensional phenomenon that is not simply coextensive with hunger. Importantly, it has been proposed that experiences of psychological uncertainty about future access to sufficient food supplies can elicit a wide range of both compensatory appetitive behaviors and metabolic maladaptations, which in turn can lead to the observed chronic health conditions.[3] That these health effects are often limited to women in high-income countries has significant public health

[1] Paula Braveman and Laura Gottlieb, “The Social Determinants of Health: It's Time to Consider the Causes of the Causes,” *Public Health Reports* 129, no. 1_suppl2 (2014): 19-31, https://doi.org/10.1177/00333549141291s206.
[2] Barbara A. Laraia, “Food Insecurity and Chronic Disease,” *Advances in Nutrition* 4, no. 2 (January 2013): pp. 203-212, https://doi.org/10.3945/an.112.003277.
[3] Daniel Nettle, Clare Andrews, and Melissa Bateson, “Food Insecurity as a Driver of Obesity in Humans: The Insurance Hypothesis,” *Behavioral and Brain Sciences* 40 (2016), https://doi.org/10.1017/s0140525x16000947.

implications. Moreover, this fact might offer important clues about the necessary conditions that bind food insecurity to chronic health.

Uncertainty about the future and chronic health, both time-dependent concepts, point to the analytic importance of the temporal dimension of food insecurity. Yet, this dimension has remained largely absent from most contemporary research of food insecurity in high-income nations. Traditional survey instruments developed for the purpose of measuring food insecurity do not distinguish between short-term experiences of food insecurity caused by abrupt changes to living conditions and long-term experiences resulting from structural vulnerabilities. If this temporal dimension is to have the potential to explain gender disparities of food insecurity and chronic health outcomes and/or inform public policy interventions, then new sources of data with the requisite temporal granularity will have to be found.

To this end, the expansion of food banks in the United States and other wealthy English-speaking nations, which interestingly has coincided with the proliferation of food security research, offers a rich source of food security data that has been largely unexploited in the academic literature. Publicly available, deidentified food bank service records have the precision needed to explore the temporal dimension of food insecurity and open new potential paths of inquiry?

2. Literature Review

2.1 Definition and Measurement of Food Insecurity

Numerous studies have examined the impact that social determinants exert on public health outcomes with some estimates suggesting that they are responsible for as much as 85-90% of preventable mortality in the United States.[4] Food insecurity, in particular, has been identified

[4] J. Michael Mcginnis, Pamela Williams-Russo, and James R. Knickman, "The Case For More Active Policy Attention To Health Promotion," *Health Affairs* 21, no. 2 (2002): pp. 78-93, https://doi.org/10.1377/hlthaff.21.2.78.

as a key contributor. While modern agriculture has all but eliminated famine and starvation in the developed world, food insecurity continues to persist in wealthy nations, often manifesting in ways beyond simple food deprivation.[5] The United States Department of Agriculture (USDA), the government agency responsible for "obtaining data on the prevalence of food insecurity,"[6] defines food insecurity as "the limited or uncertain availability of nutritionally adequate and safe foods or limited or uncertain ability to acquire acceptable foods in socially acceptable ways."[7] This definition captures the multidimensional nature of the concept. In addition to the overall quantity of food, food insecurity can also be experienced as a function of diminished nutritional quality, psychological anxiety, and social stigmatization.[8]

Because food insecurity is such a complex phenomenon, no single measurement can capture all of its aspects.[9] Traditionally in the United States, food security has been measured by the Food Security Supplement (FSS), which since 1995 has been administered as a supplemental questionnaire to the Census Bureau's Current Population Survey. These data are analyzed and reported regularly by the USDA's Economic Research Service. A household's level of food security is determined by the answers to a series of questions about behaviors and experiences associated with difficulty in meeting a household's nutritional need over the previous year. Based on the responses, households are assigned to one of four categories: high food security, marginal food security, low food security, and very low food security.[10] Analyses of these population

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[5] Rachel Loopstra, "Interventions to Address Household Food Insecurity in High-Income Countries," *Proceedings of the Nutrition Society* 77, no. 3 (2018): pp. 270-281, https://doi.org/10.1017/s002966511800006x.6x.

[6] Economic Research Service United States Department of Agriculture, "History & Background," https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/history-background/. (accessed November 6, 2020).

[7] Sue Ann Andersen, "Core Indicators of Nutritional State for Difficult-to-Sample Populations," *The Journal of Nutrition* 120, no. suppl_11 (January 1990): pp. 1555-1600, https://doi.org/10.1093/jn/120.suppl_11.1555.

[8] Loopstra, "Food Insecurity in High-Income Countries," 270-271.

[9] Natália Miranda Jung et al., "Gender Differences in the Prevalence of Household Food Insecurity: a Systematic Review and Meta-Analysis," *Public Health Nutrition* 20, no. 5 (October 2016): pp. 902-916, https://doi.org/10.1017/s1368980016002925.

[10] Alisha Coleman-Jensen, Christian A Gregory, and Matthew P Rabbitt; "Measurement," USDA ERS - Measurement, September 9, 2020, https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-us/measurement.

surveys, along with smaller opportunity samples of notable subpopulations, have revealed important demographic trends in food insecurity with significant public health implications.[11]

2.2 Food Insecurity and Chronic Health

By joining health assessments with Food Security Supplement survey data and demographic information, food insecurity has been linked with numerous chronic health conditions. For example, it has been shown that food insecurity is associated with poor mental health, including depression, anxiety, and psychological distress.[12] Furthermore, food insecurity has been linked to higher rates of diabetes,[13] dyslipidemia,[14] kidney disease,[15] poor cardiovascular health,[16] and obesity.[17] Compounding these vulnerabilities, food insecurity has also been associated with poor chronic disease management.[18] Notably, this research has revealed significant gender differences in the effects of food insecurity on chronic health with women being found to have higher rates of lung disease, diabetes, and obesity.[19]

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[11] Nettle, Andrews, and Bateson, " The Insurance Hypothesis," 6-7.

[12] Nicholas T Vozoris and Valerie S Tarasuk, "Household Food Insufficiency Is Associated with Poorer Health," *The Journal of Nutrition* 133, no. 1 (January 2003): 120-126, https://doi.org/https://doi.org/10.1093/jn/133.1.120.

[13] D.H. Holben and A.M. Pheley, "Obesity, Diabetes, and Blood Pressure Are Greater in Food Insecure Households in Rural Appalachian Ohio," *Journal of the American Dietetic Association* 101, no. 9 (2001), https://doi.org/10.1016/s0002-8223(01)80262-5; Nurgul Fitzgerald et al., "Food Insecurity Is Related to Increased Risk of Type 2 Diabetes Among Latinas," *Ethnicity & Disease* 21, no. 3 (June 8, 2014): 328-334.

[14] F.A. Tayie and C.A. Zizza, "Food Insecurity and Dyslipidemia among Adults in the United States," *Preventive Medicine* 48, no. 5 (2009):. 480-485, https://doi.org/10.1016/j.ypmed.2009.03.003.

[15] Tanushree Banerjee et al., "Food Insecurity, CKD, and Subsequent ESRD in US Adults," *American Journal of Kidney Diseases* 70, no. 1 (2017): 38-47, https://doi.org/10.1053/j.ajkd.2016.10.035.

[16] Hilary K. Seligman, Barbara A. Laraia, and Margot B. Kushel, "Food Insecurity Is Associated with Chronic Disease among Low-Income NHANES Participants," *The Journal of Nutrition* 140, no. 2 (2009): 304-310, https://doi.org/10.3945/jn.109.112573; Kelsey A. Vercammen et al., "Food Security and 10-Year Cardiovascular Disease Risk Among U.S. Adults," *American Journal of Preventive Medicine* 56, no. 5 (2019): 689-697, https://doi.org/10.1016/j.amepre.2018.11.016; Earl S. Ford, "Food Security and Cardiovascular Disease Risk Among Adults in the United States: Findings From the National Health and Nutrition Examination Survey, 2003–2008," *Preventing Chronic Disease* 10 (May 2013), https://doi.org/10.5888/pcd10.130244.

[17] Liping Pan et al., "Food Insecurity Is Associated with Obesity among US Adults in 12 States," *Journal of the Academy of Nutrition and Dietetics* 112, no. 9 (2012): 1403-1409, https://doi.org/10.1016/j.jand.2012.06.011.

[18] Karin Nelson et al., "Is Food Insufficiency Associated with Health Status and Health Care Utilization among Adults with Diabetes?," *Journal of General Internal Medicine* 16, no. 6 (2001): 404-411, https://doi.org/10.1046/j.1525-1497.2001.016006404.x; Hilary K. Seligman, "Food Insecurity and Hypoglycemia Among Safety Net Patients With Diabetes," *Archives of Internal Medicine* 171, no. 13 (November 2011): 1204, https://doi.org/10.1001/archinternmed.2011.287.

[19] Joan A. Vaccaro and Fatma G. Huffman, "Sex and Race/Ethnic Disparities in Food Security and Chronic Diseases in U.S. Older Adults," *Gerontology and Geriatric Medicine* 3 (2017): p. 233372141771834,

2.3 Gender Disparities

In addition to higher rates of disease, women worldwide are more likely to experience food insecurity than men.[20] Correspondingly, in the US households headed by women report both higher rates of food insecurity and are more likely to report experiencing 'very low food insecurity', which is often associated with disrupted food intake due to a lack of resources.[21] Therefore, the link between gender and food insecurity appears to be robust, affecting both size and magnitude, but there can be a number of complications when interpreting this data.

Given the prevalence of food insecurity among women, foregrounding gender issues is important to any discussion of food insecurity. But difficulties arise when attempting to make inferences about gender, an individual characteristic, from measurements of food insecurity taken at the household level. For example, one study of Canadian households found that gender disparities in rates of "food insecurity in non-married households are attributable to women's socio-economic disadvantage [while in] married households, women appear to report higher levels of food insecurity than men. These findings suggest a possible bias in the measurement of population-level household food insecurity in surveys."[22] This split hints at some of the factors of food insecurity that are operating differentially on the individual and the household.

"Women's traditional role in society as caregivers and preparers of food for the family, as well as an increasing recognition of their role as heads of households, further support the consideration of women as a special group to evaluate the effect, consequences, and areas for

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https://doi.org/10.1177/2333721417718344.; Elizabeth J. Adams, Laurence Grummer-Strawn, and Gilberto Chavez, "Food Insecurity Is Associated with Increased Risk of Obesity in California Women," *The Journal of Nutrition* 133, no. 4 (January 2003): 1070-1074, https://doi.org/10.1093/jn/133.4.1070.

[20] Nzinga H. Broussard, "What Explains Gender Differences in Food Insecurity?," *Food Policy* 83 (2019): 180-194, https://doi.org/10.1016/j.foodpol.2019.01.003.

[21] Jung et al., "Gender Differences in Household Food Insecurity," pp. 902-903

[22] Jesse Matheson and Lynn Mcintyre, "Women Respondents Report Higher Household Food Insecurity than Do Men in Similar Canadian Households," *Public Health Nutrition* 17, no. 1 (July 2013): 40-48, https://doi.org/10.1017/s136898001300116x.

intervention in terms of food insecurity."[23] Decades of research have noted the systemic economic disparity faced by women with recent research showing full-time female earnings are just 83% of their male counterparts.[24] This fact would support the finding that increased food insecurity in single-adult households headed by women is a consequence of relative economic disadvantage. In married households, the reporting bias might be more motivated by societal gender norms. Men may be less likely to report food insecurity because of a greater sense of personal shame or social stigmatization for their perceived failure to live up to the cultural role of breadwinner or providers. On the other hand, it could be that women are more likely to feel a greater psychological burden of food insecurity. That is to say that women, in the culturally gendered role of domestic caretaker primarily responsible for childcare and food preparation, may be more inclined to worry about future sources of food, or more likely to adopt severe coping strategies, such as disrupting their own food intake to ensure adequate food supplies for the household, a fact that may contribute to a greater appreciation and recall of household food insecurity. Disentangling the factors of food insecurity operating at the level of the individual when the fundamental measures of that food insecurity occur at the household level therefore is a significant analytic challenge.

2.4 Chronic vs. Transient Food Insecurity

One under-examined feature of food insecurity is its temporal dimension. Because the Food Security Supplement, and similar food security questionnaires, ask respondents to consider their experiences over the previous 12-month period, much of the food security research in wealthy nations is blind to differences in the duration and regularity of the experience of food insecurity on timescales less than one year. Yet, in the developing world, where seasonal

[23] Louise C Ivers and Kimberly A Cullen, "Food Insecurity: Special Considerations for Women," *American Journal of Clinical Nutrition* 94, no. 6 (December 2011): 1740S, https://doi.org/10.3945/ajcn.111.012617.
[24] Leib Litman et al., "The Persistence of Pay Inequality: The Gender Pay Gap in an Anonymous Online Labor Market," *PLoS One* 15, no. 2 (February 21, 2020), https://doi.org/ 10.1371/journal.pone.0229383.

fluctuations in food availability and famine are still common sources of food insecurity, the concepts of chronic and transitory food insecurity are more common. The World Bank's definition of food security, which parallels but is distinct from the USDA's definition, in fact has an explicit reference to time stating, "Food security has to do with access by all people at all times to enough food for an active and healthy life."[25] Definitions of chronic and transitory food insecurity pick up on this reference to a temporal dimension when positing that "chronic food insecurity is long-term or persistent, while transitory food insecurity is short-term and temporary."[26]

Operationalizing this temporal dimension of food insecurity in wealthy nations could have important explanatory potential, particularly for the observed gender disparities as they relate to chronic health. The opportunity here arises because the concept of chronic food insecurity potentially binds the structural socio-economic conditions that impose higher rates of poverty on women to the chronic health outcomes that manifest in higher rates of food-insecure women than food-insecure men, namely obesity and diabetes. This linkage would depend on two distinct criteria: first, a theoretical mechanism by which chronic food insecurity might produce these particular chronic health conditions, and second, evidence that the women are, in fact, more likely to experience higher rates of chronic food insecurity.

[25] World Bank. "Poverty and Hunger: Issues and Options for Food Security in Developing Countries." The World Bank Group. Accessed November 11, 2020. http://documents1.worldbank.org/curated/en/166331467990005748/pdf/multi-page.pdf

[26] Stephen Devereux, "Distinguishing between Chronic and Transitory Food Insecurity in Emergency Needs Assessments" (Rome, Italy: United Nations World Food Programme, 2006), pp. 1-32.

2.5 The Insurance Hypothesis

On the surface, the notion that food insecurity would lead to obesity might seem counterintuitive, but research in animal physiology[27] and human psychology[28] offers a theoretical framework for this observation. Evolutionary theorists and behavioral ecologists have proposed a theoretical account of the behavioral and metabolic adaptations in humans to the experience of food insecurity that provide just such a mechanism. Called the insurance hypothesis, it "proposes that humans possess evolved mechanisms that respond to cues or experiences indicating that access to sufficient food is uncertain by increasing energy intake relative to expenditure, and hence storing more fat."[29]

Despite the compelling evolutionary explanation for the behavioral and physiological maladaptations to predictable food insecurity in a calorie-rich environment like modern wealthy nations, evidence for chronic food insecurity has been largely absent. But this may be a quintessential case of the absence of evidence being unequal to the evidence of absence, for the missing data seems largely due to the fact that the traditional instruments used to measure food insecurity, namely the Food Security Supplement, were not calibrated to capture the phenomena on these timescales. Therefore, evidence for chronic food insecurity in wealthy nations will require a different source of data.

2.6 Food Bank Utilization

Starting in the 1980s, the United States began to see a marked expansion of the charitable food sector, a situation that has since been paralleled in other relatively wealthy nations. It has

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[27] Marshall D. Mccue, "Starvation Physiology: Reviewing the Different Strategies Animals Use to Survive a Common Challenge," *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology* 156, no. 1 (2010): 1-18, https://doi.org/10.1016/j.cbpa.2010.01.002.

[28] Fania C.M. Dassen, Katrijn Houben, and Anita Jansen, "Time Orientation and Eating Behavior: Unhealthy Eaters Consider Immediate Consequences, While Healthy Eaters Focus on Future Health," *Appetite* 91 (2015): 13-19, https://doi.org/10.1016/j.appet.2015.03.020.

[29] Nettle, Andrews, and Bateson, " The Insurance Hypothesis," 9.

been observed that programs such as soup kitchens, which provide prepared meals, and food banks, which receive, warehouse, and distribute food donations from individuals, organizations, and food industries have tended to expand at times of state welfare retrenchment and increased conditionality.[30] This expansion of the charitable food sector anticipated and paralleled the proliferation of food insecurity research as the issue of hunger gained prominence in communities throughout the country.

Like many other sectors of society in recent years, food banks have begun to collect and maintain detailed, digital data records of their service operations. These efforts have increased food bank efficiency by improving donation collection and distribution. Moreover, these data have shown potential to improve user experiences by anticipating customer needs and reducing the economic friction between supply and demand. But these food bank user data also have promise as an analytic tool for food security researchers. Unlike the Food Security Supplement, food bank user data does not rely on self-reporting and recall, and quite importantly, these data have the temporal granularity necessary for a precise measurement of the temporal dimension of food insecurity.

3. Data and Methods

In order to operationalize the temporal dimension of food insecurity and analyze its relationship with gender, service records from the 2017 fiscal year were obtained from the Mid-Ohio Foodbank, the nation's 5th largest produce distributing food bank.[31] Collected for the purpose of better understanding the size, scope, and location of food insecurity in the community, these data were further integrated and made publicly available as part of the broader Smart Columbus initiative, a wide-ranging program sponsored by the United States Department of

[30] Lambie-Mumford, "Growth of Food Banks." pp. 8-9

[31] Mid-Ohio Foodbank, "Annual Report Mid-Ohio Foodbank: Fiscal Year 2018." midohiofoodbank.org, 2018. https://www.midohiofoodbank.org/who-we-are/about-us/ (accessed November 27, 2020).

Transportation, which compiled data from numerous public and private sources with an aim to "accelerate human progress through open mobility."[32]

Containing more than 490,000 individual service records, these data were joined with household data of more than 86,000 households.[33] Each household was associated with a specified census tract FIPS code, "an 11-digit number that uniquely identifies each census tract in the United States,"[34] permitting the inclusion of census tract estimates of various socio-economic variables. Census tract estimates were obtained through the Federal Financial Institutions Examination Council, an "interagency body...responsible for developing uniform reporting systems for federally supervised financial institutions...and to make recommendations to promote uniformity in the supervision of financial institutions."[35]

In order to restrict the analysis on households experiencing food insecurity, service records were limited to food benefits only while other forms of aid (financial counseling, clothing donations, emergency services, etc.) were excluded. These data were then aggregated at the household level, and utilizing the dates and times of the service records, calculations were performed to produce the total number of trips to the food bank and the average number of days between visits for each household in the dataset. Because this interval calculation required more than one visit to be performed, incorporating this measure necessarily limited the data further to only those households visiting the food bank more than once during the 2017 fiscal year. In the end, the dataset used for analysis contained 195,055 individual service records representing 29,783 households.

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[32] Smart Columbus, "About: SmartColumbus." https://smart.columbus.gov/about (accessed October 13, 2020).

[33] data.world, "Smart Columbus Operating System's Datasets," https://data.world/smartcolumbusos (accessed September 4, 2020). ; data.world, "Recipient Family Demographics and Services Offered at Food Pantries," https://data.world/smartcolumbusos/1832d63a-f12e-4ff2-a39b-7bf12d092136 (accessed September 4, 2020)

[34] Federal Communications Commission, "Form 477 Census Tract Information," May 19, 2014. https://www.fcc.gov/general/form-477-census-tract-information. (accessed December 2, 2020).

[35] Federal Financial Institutions Examination Council. "About the FFIEC" April 15, 2020. https://www.ffiec.gov/about.htm (accessed November 30, 2020).

To investigate the relationship between gender and chronic food insecurity, multivariate ordinary least squares regression analyses were performed on log-transformed values of both the cumulative number of visits and the average interval between visits. Log transformations were performed to help adjust for the exponential decay displayed by each measure, improving the normality of the distributions and the fit of the ordinary least square models. Jointly reflecting the frequency and severity of food insecurity in a household, these two variables were taken as approximate measurements of a household's experience of food insecurity through time. The total number of trips that a household makes to the food bank is a reflection of both the severity of food insecurity, but also its persistence. When considered along with the average interval between trips, a fuller picture emerges with fewer trips and shorter intervals reflecting transient experiences of insecurity and more trips and longer intervals indicating chronic insecurity.

Variables reflecting family composition were included as additional control variables. It was presumed that more individuals, especially those not of working age, would add additional strain on a household's food resources and decrease a household's food security. Moreover, it might also be expected that female-headed households would be systematically more likely to have children, therefore imposing an additional burden and further straining food resources. In addition, two variables (distance traveled and a dummy variable for living within a city) were included to control for a household's access to foodbanking services. It is assumed that all else being equal, the further one must travel to a food bank, the harder those services are to obtain. But all miles are not equal, 10 miles of country road is not the same as 10 miles through a dense metropolis, and of course, access to public transportation varies by region. Racial data was not directly available but was estimated by the minority share of the household's census tract population. Economic standing was similarly approximated from census tract estimates of the percentage of the population living in poverty. Finally, socio-economic standing was further captured by the inclusion of census estimations of the median age of homes, the number of homes that were occupied by their owners and the percentage of houses that were vacant.

All subsequent calculations were performed using the statistical software R.[36]

4. Results

Table 1 displays the results of two separate multivariate regressions on the log of the average interval between visits to the food bank.

Table 1

Multivariate OLS Regression on Log of the Average Interval Between Food Bank Visits

	Model 1	Model 2
Intercept	*** 3.357 ***	*** 3.671 ***
Gender (Female)	*** 0.056 ***	*** 5.707 ***
Ages < 5	-0.016	-2.925
Ages 5 to 17	-0.006	6.547
Ages 18 to 24	0.0001	* 1.619 *
Ages 25 to 34	0.011	-5.236
Ages 35 to 59	*** -0.029 ***	* -1.205 *
Ages 60 to 64	** -0.048 **	* 2.991*
Ages 65 to 84	*** -0.063 ***	7.696
Ages > 85	0.063	2.115

[36] R Core Team. (2019). R: A language and environment for statistical computing (Version 3.6.1). R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/

Distance Traveled (miles)	** 0.002 **	-4.192
City (Yes)	-0.028	3.361
% Minority	0.0004	4.680
% in Poverty	0.0005	-3.254
Median Home Age	*** 0.003 ***	*** 2.292 ***
% Homes Owned	0.074	5.476
% Homes Vacant	** 0.191 **	1.305
Cumulative Visits		*** -4.236 ***
Adjusted R^2	0.0067	0.1853

Significance Codes: ***p<0.001*** **p<0.01** *p<0.05*

Data sources: https://discover.smartcolumbusos.com & https://www.ffiec.gov/census/

The two models differ only by the inclusion of a control variable for cumulative appearances in Model 2, though the importance of this control is noted by the appreciable difference between the adjusted R^2 values of the two models. Looking at that variable, it is evident that each additional visit added to a household's total significantly reduced its expected average interval. This makes some intuitive sense, more visits translates into fewer days between visits, and we should expect these two time-dependent measures to be highly correlated.

Moving on to the other variables, it is clear that after controlling for other variables, gender was an important factor with female-headed households having a significantly greater average interval between appearances. This was true independent of whether the total number of visits was controlled for or not. By contrast, most other variables reflecting household composition were diminished in significance after controlling for cumulative visits. Still, additional household members aged 18 to 24 and 60 to 64 were associated with increases in the average interval while additional members aged 35 to 59 were associated with a decrease in the

average interval. The variables corresponding to the relative ease of access to food bank services (i.e., distance traveled and city) were not strongly associated with the average length of interval, and neither was minority status. Finally, of the variables reflecting socio-economic status, only the median home age, which showed that older homes corresponded with longer intervals, maintained its significance after controlling for the total number of visits.

Table 2 similarly displays the results of two multivariate regression analyses, this time with the log of cumulative visits as the dependent variable. This time Model 3 and Model 4 differ only in that the latter controls for the average interval between visits. Again, this control for the complementary time-dependent variable was significant both in terms of its coefficient (i.e., an increase in the average interval was associated with significantly fewer cumulative visits) but also by the appreciable difference that the inclusion of that control made toward the adjusted R^2 of Model 4.

Table 2

Multivariate OLS Regression
On the Log of Cumulative Visits
To the Food Bank

	Model 3	**Model 4**
Intercept	*** 1.661 ***	*** 1.933 ***
Gender (Female)	-0.004	* 1.896 *
Ages < 5	*** 0.029 ***	** 2.329 **
Ages 5 to 17	*** 0.019 ***	*** 1.873 ***
Ages 18 to 24	** 0.024 **	*** 2.945 ***
Ages 25 to 34	*** -0.029 ***	*** -2.644 ***
Ages 35 to 59	*** 0.047 ***	*** 3.710 ***

Ages 60 to 64	*** 0.179 ***	*** 1.549 ***
Ages 65 to 84	*** 0.159 ***	*** 1.351 ***
Ages > 85	*** 0.173 ***	*** 1.388 ***
Distance Traveled (miles)	*** -0.006 ***	*** -4.454 ***
City (Yes)	*** 0.087 ***	*** 7.907 ***
% Minority	*** -0.001 ***	*** -6.944 ***
% in Poverty	0.001	6.160
Median Home Age	** -0.001 **	* -6.694 *
% Homes Owned	* -0.070 *	-3.807
% Homes Vacant	* -0.171 *	-7.673
Average Interval		*** -7.714 ***
Adjusted R^2	0.02066	0.1975

Significance Codes: ***p<0.001*** **p<0.01** *p<0.05*

Data sources: https://discover.smartcolumbusos.com & https://www.ffiec.gov/census/

Turning attention to the other variables, it is noteworthy that gender was not significant for Model 3, but did gain statistical significance in Model 4 where female-headed households were associated with an increase in the total number of visits. Unlike Models 1 and 2, which were fit to the average interval, household size and composition had a universally significant effect upon estimates of the total number of trips to the food bank with more household members being correlated with more appearances, but with one notable exception. Each additional household member aged 25 to 34 was associated with fewer visits to the food bank. This result likely reflects the fact that individuals of this age are the most likely to find work consistent employment in the service industry and/or unskilled labor market. Variables of access were also universally significant with a farther distance traveled corresponded with fewer trips and living in the city corresponded with more. Again, median home age had a significant effect with older homes/neighborhoods associated with fewer visits. The percentages of homeownership and

vacant homes were not significant after controlling for the average interval length. Interestingly, a higher rate of minorities living in one's community corresponded with fewer trips to the food bank, but perhaps most curious of all, poverty rate was not a significant factor in any of the four models reported.

5. Conclusion

Before proceeding to draw any conclusions, it is important to first define the limits of the present analysis. To begin, it must be acknowledged that the use of food bank data to capture the temporal dimension of food insecurity necessarily restricts that measurement to only those households that avail themselves of food bank services. In addition to skewing the sample toward those households experiencing very low food security, and away from those households experiencing merely low or marginal food security, this restriction might also under-represent marginalized communities that may face greater social and psychological barriers to the voluntary acquisition of services. It is entirely possible that non-native English speakers, the physically or mentally disabled, homeless populations, and others may be systematically under-sampled when relying exclusively on food bank records to measure food insecurity. This same logic also applies to the further restriction to households with more than one visit to the food bank for the purposes of the interval calculation. It is unknown how the various physical, psychological, and social burdens of food insecurity might interact with the voluntary nature of seeking food bank services to affect the sample, or how that sample might differ from the true population of food-insecure households. For example, it should be noted that female-headed households made up 68.6% of all households in these food bank service records. While it is a common observation that women are more likely to experience food insecurity, estimates of the share of food-insecure households led by women are difficult to come by, and in any case, it is difficult to know whether 68.6% is an accurate reflection of the gender disparity, or if this disparity is inflated, possibly due to the

women's dominant cultural role of domestic caretaking and that role's traditional responsibility with regards to food acquisition and food preparation.

In addition to considerations regarding the make-up of the data sample, it is also important to recall that the deidentified food bank user data used in this analysis did not contain direct measures of racial or economic status and that these inputs had to be estimated from census tract data. While it can be argued persuasively that the inclusion of these estimates is better than not, it is simply the case that one wouldn't necessarily expect a food bank visitor from a community to be identical to the median census tract constituent. This gap between a household receiving food bank services and the median household and the distinct possibility that the difference may vary systematically, with the difference being smaller in low-income communities than in high-income communities, could be a serious limitation with the present data. Fortunately, there is some hope that this shortcoming could be addressed in future data collections.

Finally, the dependent measures (i.e., the cumulative number of visits and the average interval between visits) themselves have some limitations. The necessary restriction of the dataset to households with more than one visit to the food bank has already been mentioned, but it was also the case that both dependent measures had large ranges of values and were non-normally distributed. Log transformations were employed to improve the coefficient estimations of the regression analysis, but there remained a rather large variance, which limited the fit of the present models to accounting for roughly 20% of the variation in the dependent measures.

Yet, these limitations should merely qualify any conclusions, not disqualify them entirely. Including a temporal dimension in a measurement of food security has demonstrable analytic potential and, even acknowledging the limitations, there are some interesting observations to be made from the present analysis. First, the size and composition of a household had a fairly direct effect on the total number of trips to the food bank. With the exception of 25- to 34-year-olds who were negatively correlated with food bank visits, more individuals in a

household translated into more trips to the food bank. This suggests, in the present sample at least, individuals outside of the 25- to 34-year age group tend to be a net drain on food resources. But notably, the impact on the regularity of visits was less clear with some age groups associated with shorter intervals, some longer, and most having no significant effect at all.

By contrast, it was notable how little the socio-economic estimates indicators were associated with the temporal measures of food insecurity. With the exception of median home age, none of the other indicators were universally significant, and perhaps most surprisingly, the percent of families living in poverty in a household's community never gained significance, despite the reasonable expectation that poverty and food insecurity would be highly correlated. That this was not the case could point to the limitations of census tract estimates previously discussed, but it is also possible that economic security was, holding other variables, better captured by the other variables in the model. A similar explanation might hold for minority share, which was counterintuitively associated with fewer total visits. If economic security was captured by other factors (e.g., percent of owner-occupied or vacant homes) then this negative correlation with food insecurity may actually signify an unequal distribution of access to food bank services in communities with higher minority populations. This would be a potentially interesting area for follow-up research.

Finally, turning to gender, the variable whose hypothesized relationship to the temporal dimension motivated the present analysis. Recall that observed chronic health disparities were conjectured to be linked to persistent structural inequities resulting in women being more likely to suffer food insecurity as a chronic condition and thus more likely to exhibit compensatory appetitive behaviors and metabolic maladaptations to a calorie-rich environment. Analysis of the relationship between gender and the two temporal measures of food insecurity revealed three key facts. First, female-headed households received more than twice as many food bank services as male-headed households. Second, female-headed households displayed significantly longer intervals between food bank visits. Third, after controlling for the average interval, female-

headed households were also associated with a greater number of cumulative visits to the food bank.

Taken together, these facts lend concrete evidence to the notion that women may be more likely to experience food insecurity as a chronic condition. Importantly, the longer interval between food bank appearances not only suggests that the experience of food insecurity is on average operating over a longer time-horizon, but it may also be indirect evidence of compensatory behaviors, namely stretching food resources over longer periods of time. In order to conclusively demonstrate a direct link between chronic food insecurity and chronic health outcomes, direct measurements of chronic health would need to replace indirect demographic estimates, but the suggestion is there in the data, and that suggestion is evidence enough of the analytic potential of using food bank utilization to introduce the temporal dimension to food security research.

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Curriculum Vitae

Andrew Sherwood studied Philosophy and Neuroscience at Allegheny College where he was awarded a Keck Research Fellowship that he pursued at Johns Hopkins University. After graduation, Andrew returned to Johns Hopkins to conduct research at the Neurogenetics and Behavior Center where he specialized in the behavioral biology of learning, memory and addiction and he was a key contributor to an investigation of the neurobiology of aging, a project that led to the development of a novel pharmaceutical with the promise of blunting the effects of age related cognitive decline. Andrew studied Government Analytics with a concentration in statistical analysis through Johns Hopkins University’s Advanced Academic Programs. Going forward he hopes to combine his passion for data analysis with his expertise in goal-driven and cue-driven behavior to promote a greater understanding of social action and an improved public policy.